Status of CJPL-II

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CJPL 中国锦屏地下实验室 China Jinping Underground Laboratory

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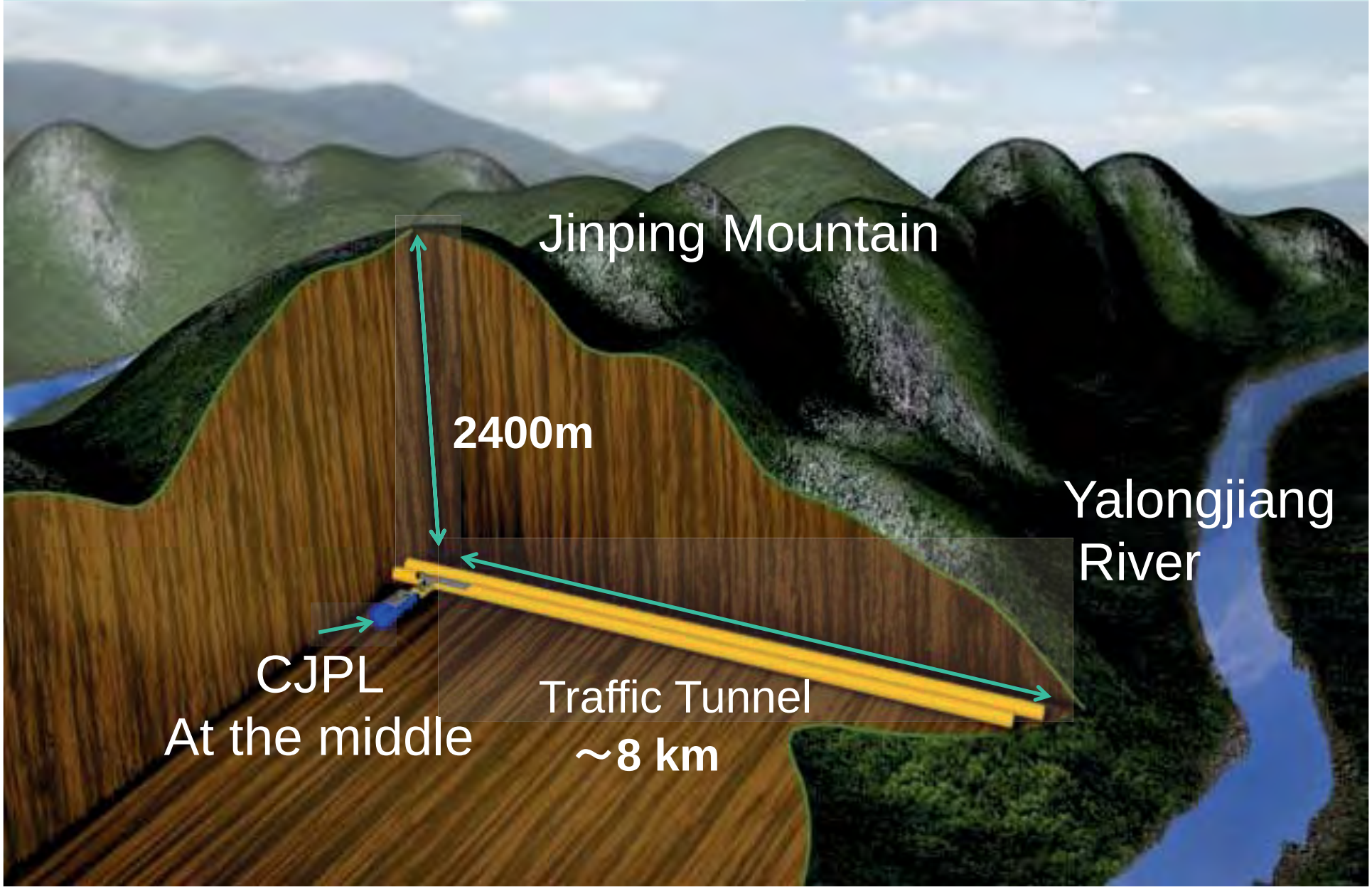
I. A BRIEF CJPL INTRODUCTION

CJPL 中国锦屏地下实验室
China Jinping Underground Laboratory

China JinPing Underground Laboratory(CJPL)



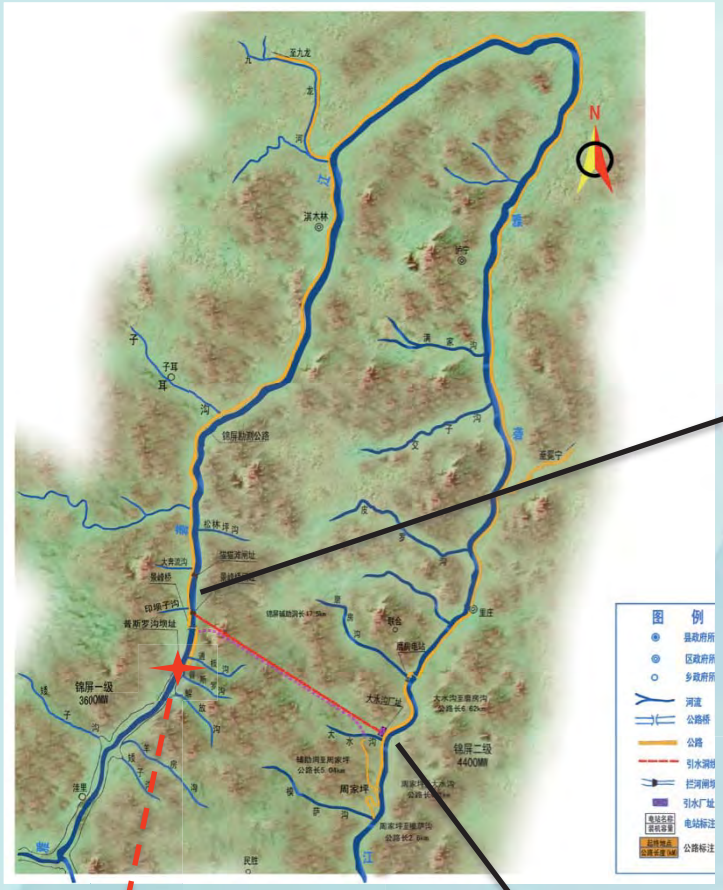
CJPL position Sichuan Province

The Yalong River Hydropower

Yalong River Hydropower Development Company (Yalong Hydro) started to develop the hydro-energy for the entire river since 1990s.

Yalong River make a great bend around Jinping mountain. Two Hydroelectric power plants are constructed on the bend since 2005 by Yalong Hydro.

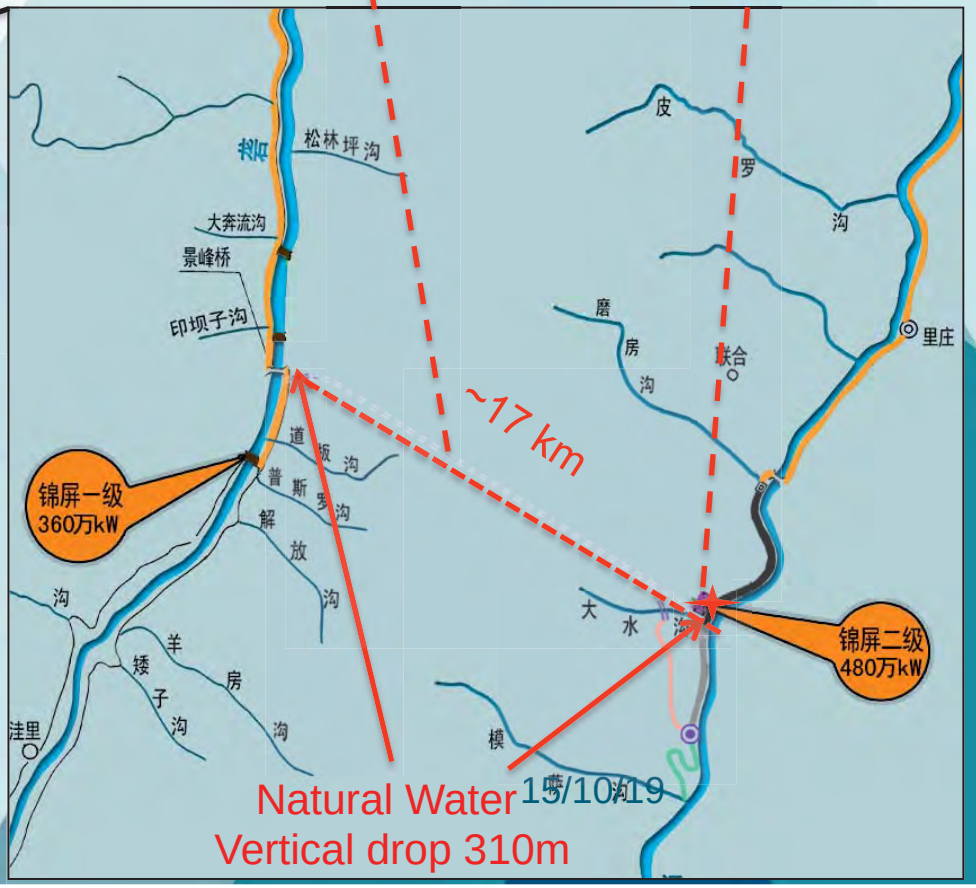
Jinping Hydroelectric Power Plants



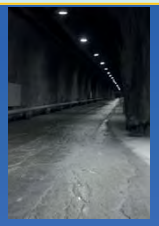
Jinping-I
Power Plant
3600MW
(6×600MW)

4 hydraulic
tunnels
Φ13m×16.6km

Jinping-II
Power Plant
4800MW
(8×600MW)



CJPL Site and Jinping-II Hydropower Station



Traffic tunnel x 2

Intake

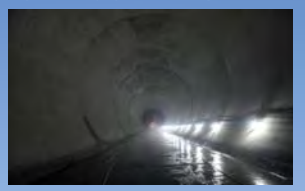
Drainage tunnel

CJPL-II

CJPL-I

JP – II Hydropower station

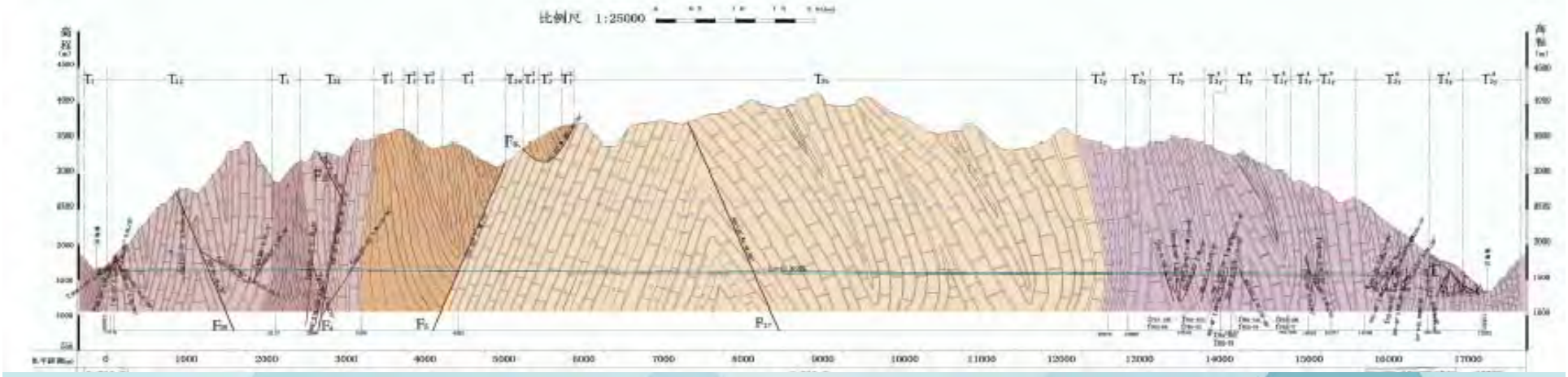
Diversion tunnel x 4

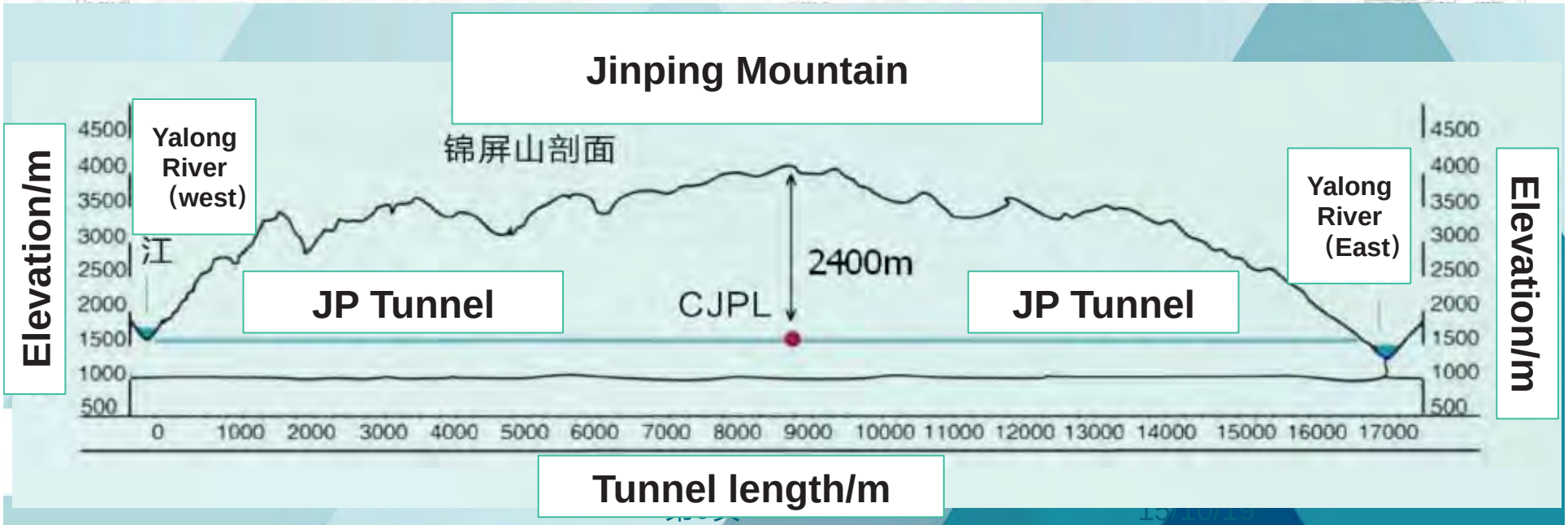


17.5km

- Seven high pressure tunnels: two auxiliary tunnels, one water drainage tunnel and four headrace tunnels
- Background radiation of marble is less than 1/100 of nature radiation
- Maximum overburden of 2525 m and principal stress of 70MPa by back analysis
- Average length of 17.7km with two curves in the end, good for comic radiation shielding.

Profile of Jinping Tunnel





Convenient communications and transportation

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Logistic Condition of CJPL

Ground building

Meeting Rooms

several meeting rooms(20-50 persons)

one large hall (260 persons)

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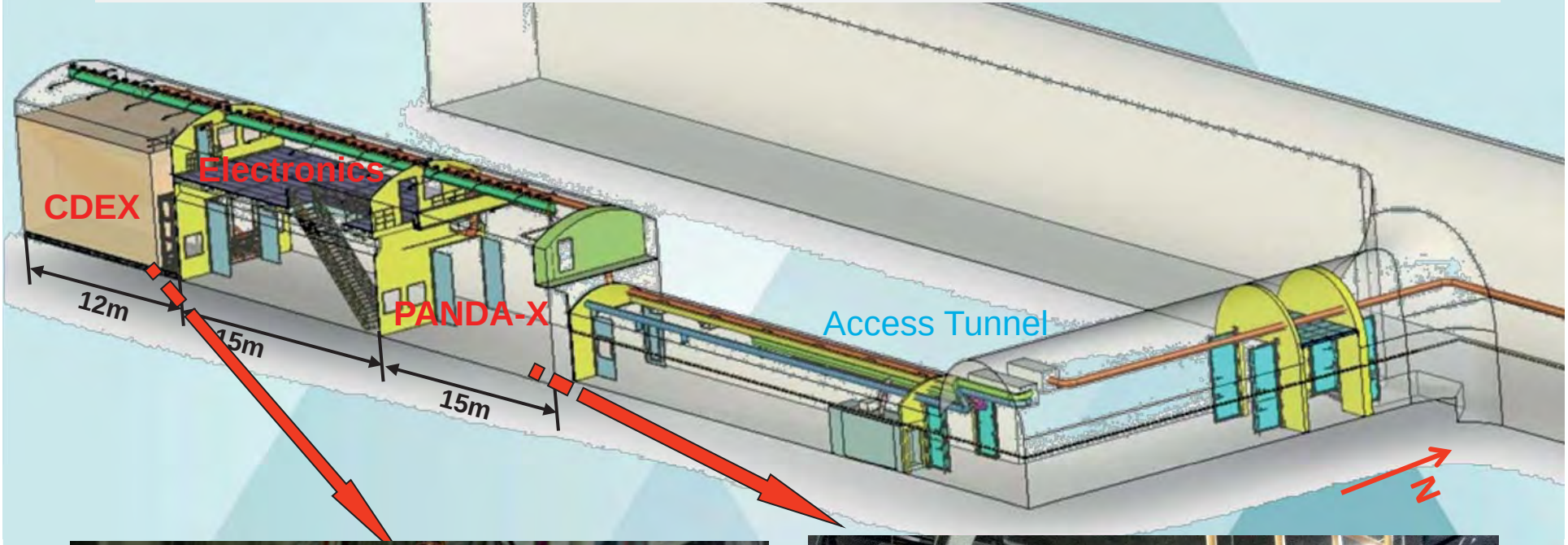
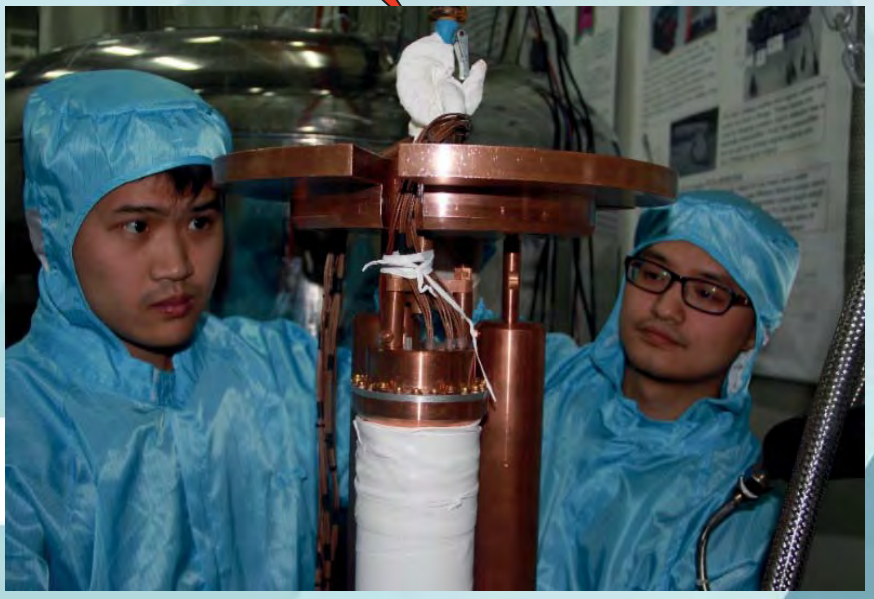
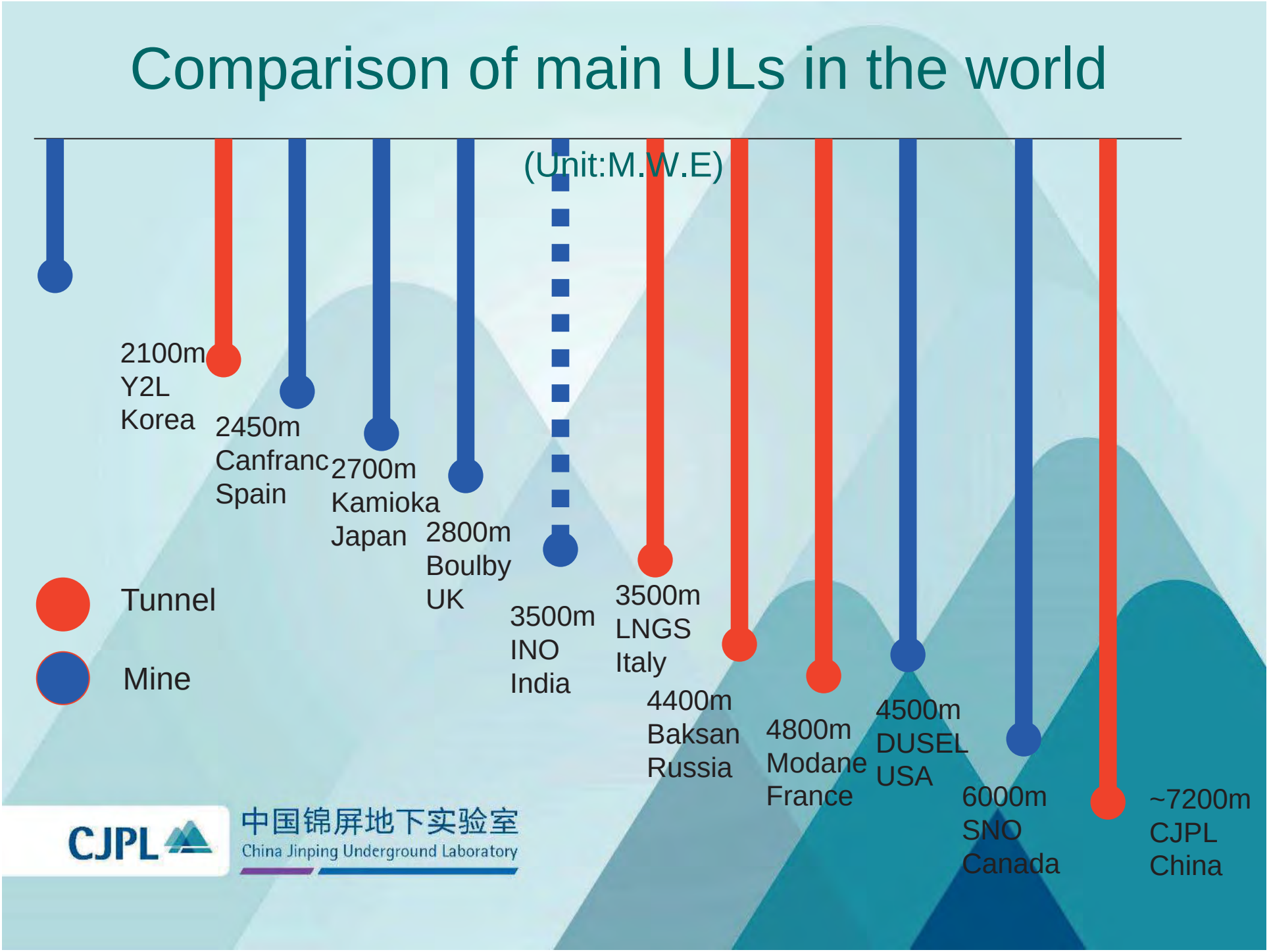
Dec. 12,2010 Openning Ceremony

CJPL-I – Dark Matter Experiment

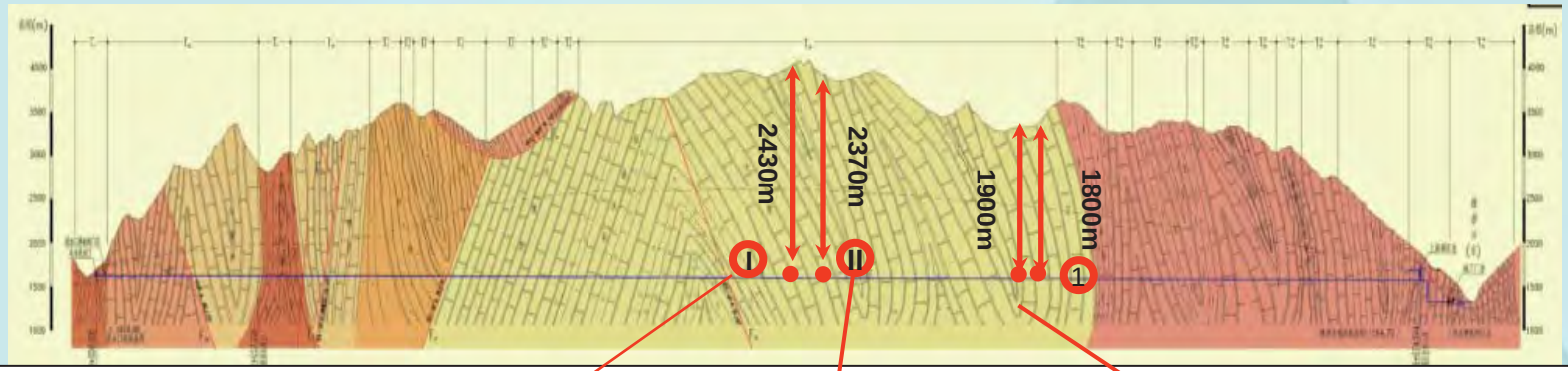




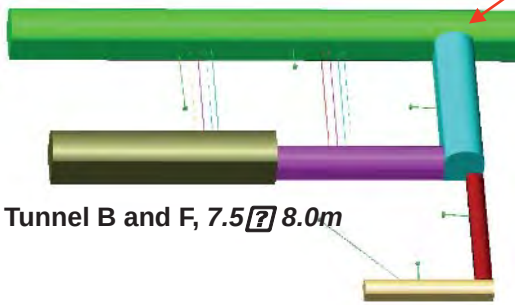
Comparison of main ULs in the world



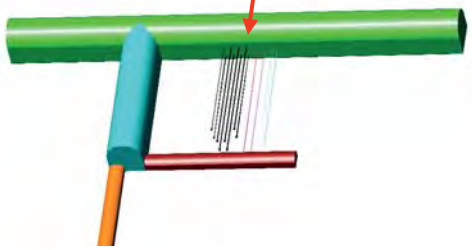
Evolution of Surrounding Rock



Auxiliary tunnel A

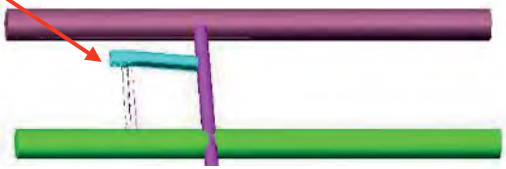


Tunnel B and F, *7.5? 8.0m*

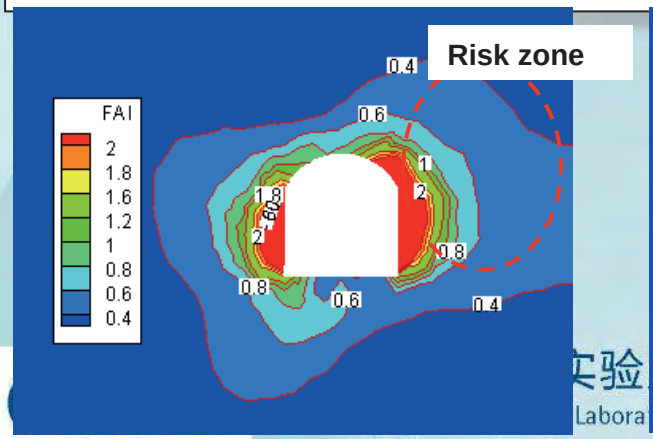


Tunnel *C, 3? 3.2m*

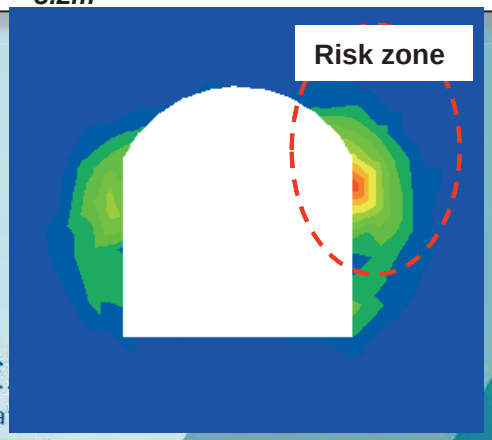
Headrace tunnel no.2, D=13.0m



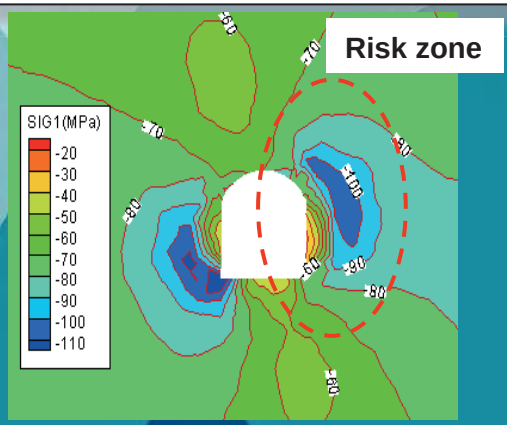
Headrace tunnel no.3, D=12.4m



Distribution of failure approach index(FAI)



Distribution of local energy released rate (LERR)



Distribution of the maximum principal stress

CJPL：laboratory with low background radiation

- Convenient traffic condition
  - Large equipment can be transported into the lab by truck
  - Staffs and visitor can get into the lab by car
- The deepest lab by rock cover in the world
  - Equal ~7000m water shielding
  - Lowest background cosmic radiation（<70 counts/m^2.y）
- Lowest background radiation
  - The best underground lab with best rock (marble) cover condition and lowest background radiation level
  - Without any high-energy radiation isotopes in the background radiation, easy for shielding
- Facilities
  - Stable electric power and communication supply
  - Good condition for Logistics services
  - Professional engineering staff

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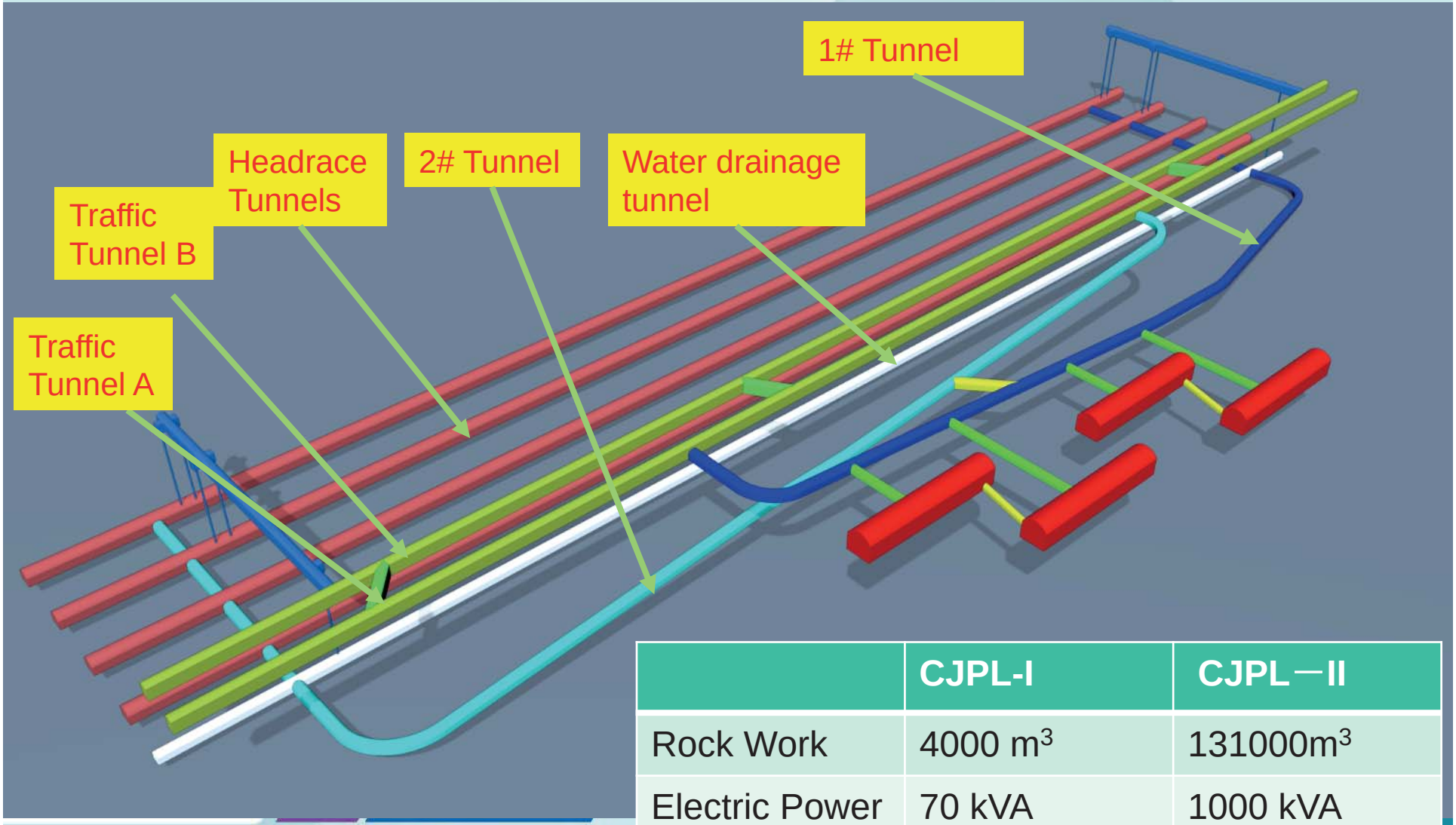
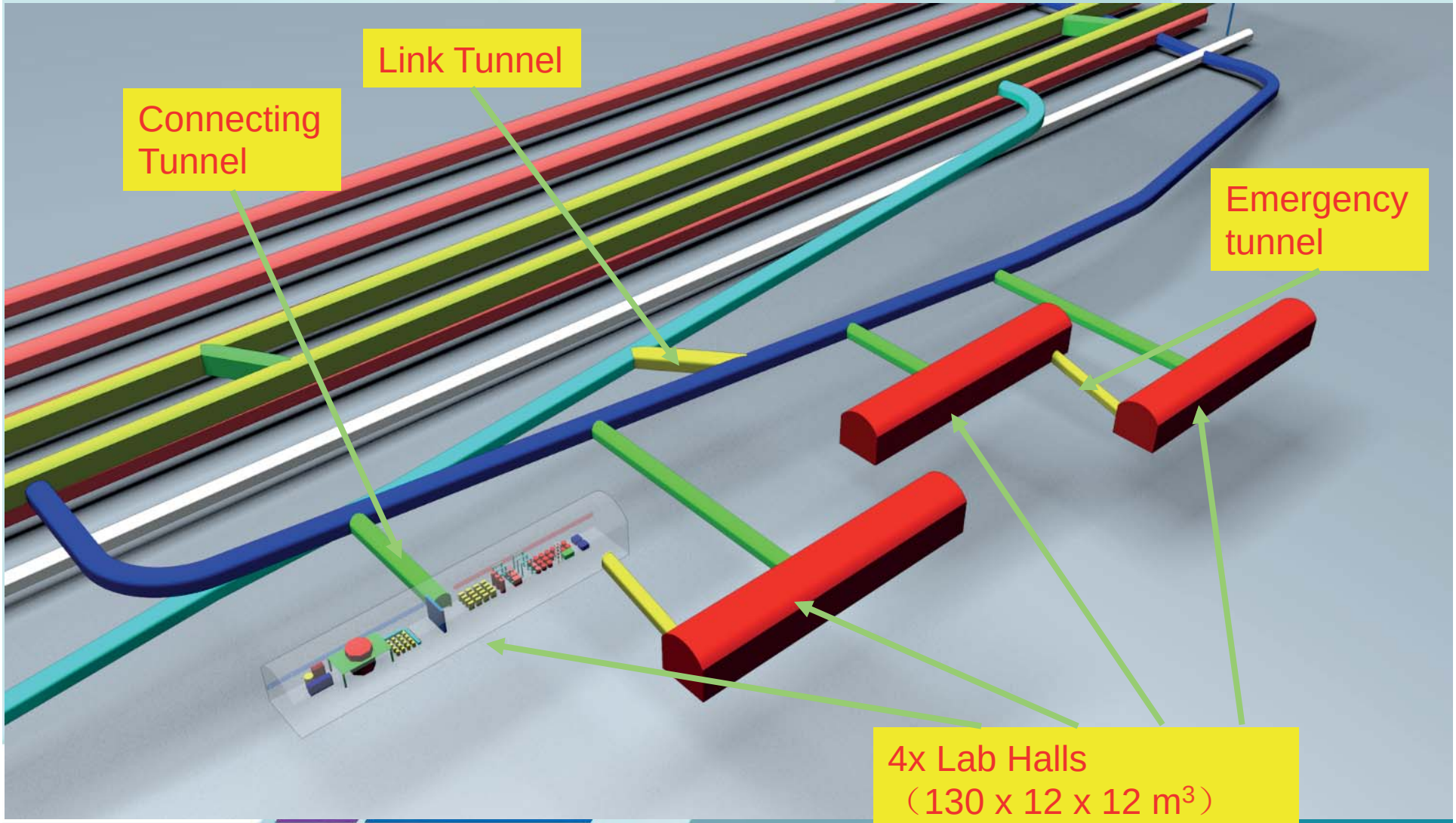
III. CJPL-II DESIGN AND EXPERIMENT PROPOSALS

Design of CJPL-II



	CJPL-I	CJPL—II
Rock Work	4000 m^3	131000m^3
Electric Power	70 kVA	1000 kVA
Fresh Air	2400 m^3/h	45000 m^3/h

Design of CJPL-II



Render Picture of Lab Hall

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钢材估量表				
编 号	规 格	单 重 Kg/m或Kg/m²	长度/面积 m或m²	总 重 Kg
1	H350X250X10X16	87.8	2815	247160
2	H550X350X10X16	128.6	9	1160
3	H400X300X10X16	104.2	5	520
4	H500X350X10X16	124.6	242	30150
5	H600X500X10X16	170.2	16.5	2810
6	HN100X50X5X7	8.9	610	5430
7	HN200X100X5.5X8	20.5	260	5330
8	2L63X6	11.5	610	7015
9	2L50X6	9	105	945
10	2L90X6	16.7	5	85
11	L63X6	5.8	14500	84100
12	吊车轨道	43	260	11180
13	节点板			47505
	总重			443390

注：1. 钢丝网用量不包括在总重内
2. 钢丝网采用丝径为4mm，孔径为30mm，面积约4736m²

Render Picture of Tunnel

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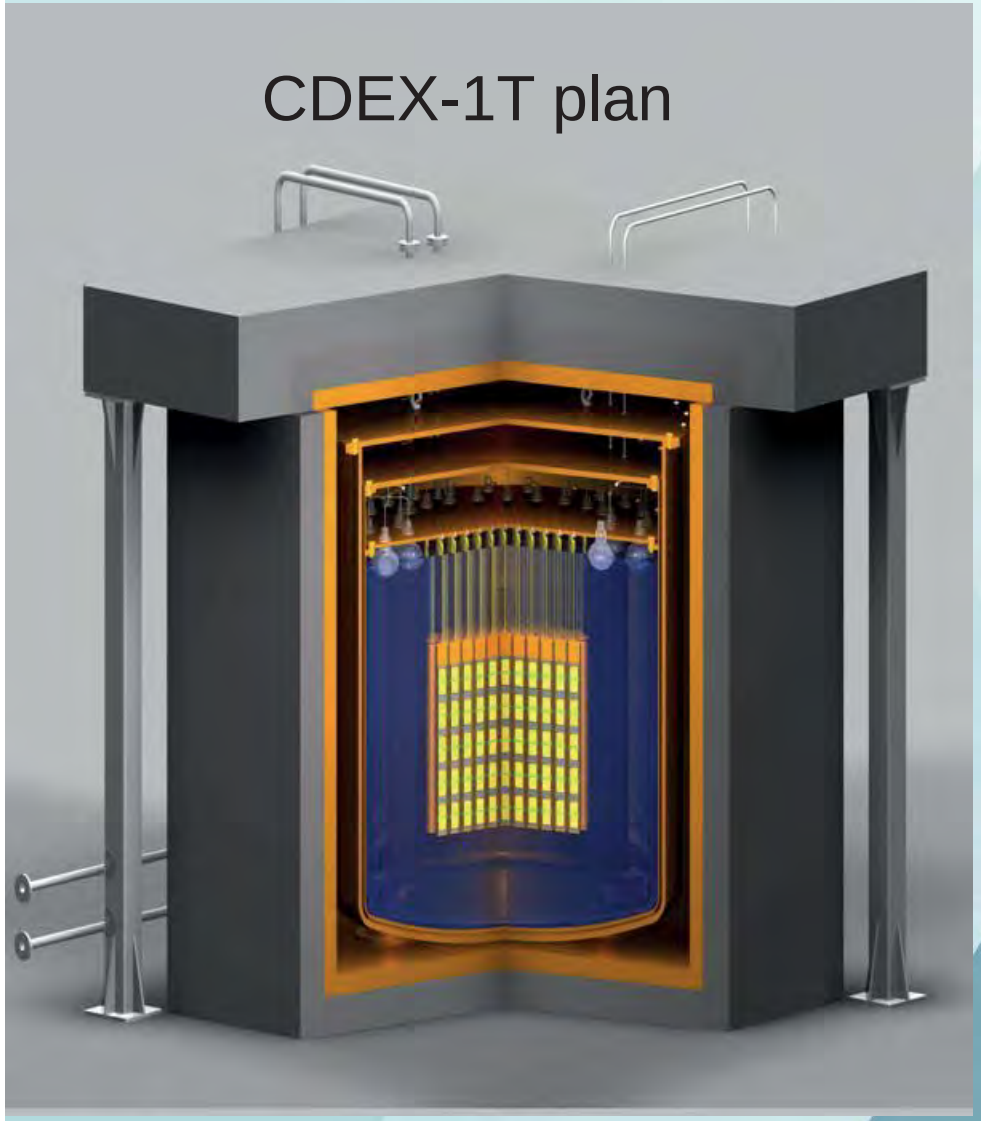
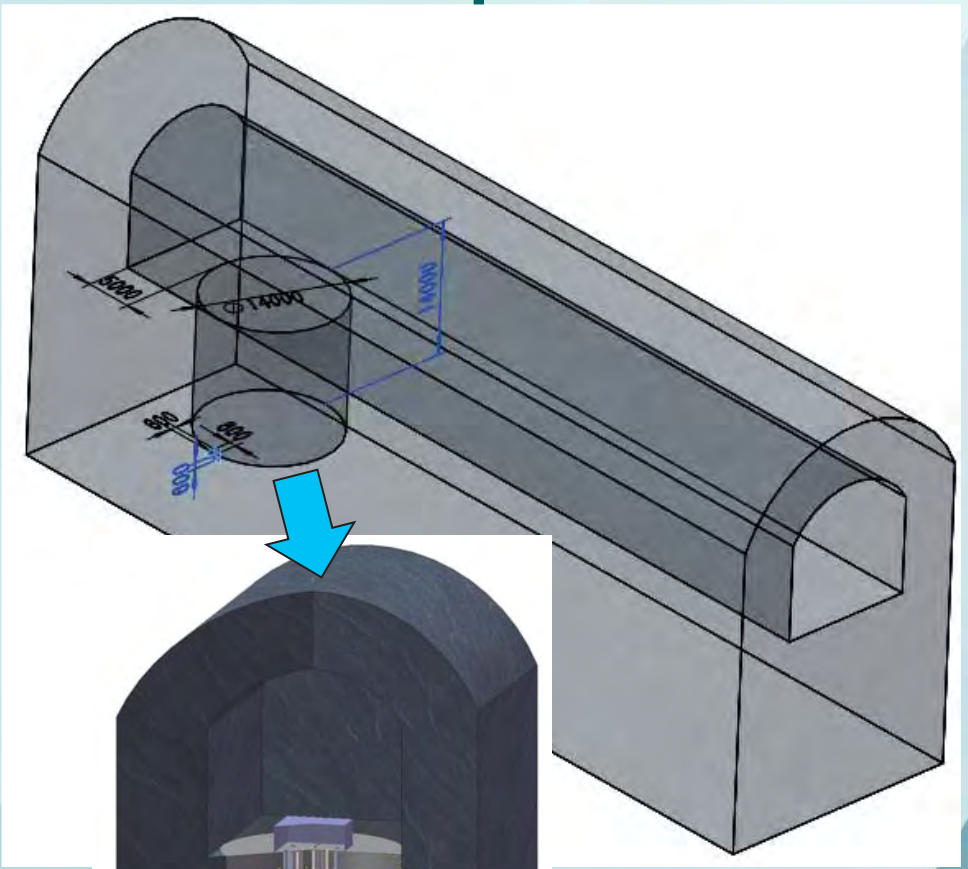
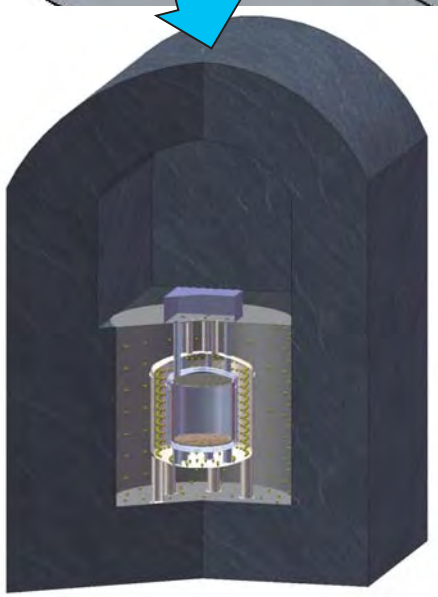
Point Contact Germanium Array Dark Matter Experiment in CJPL



- **CDEX has started CDEX-1 experiment, and the first physical results has been published, two new results submitted to PRL and PRD.**
- **CDEX-10 (PCGe+Lar AC) is testing at ground laboratory and plan to ship to CJPL in 2015.**
- **CDEX-1T multi-purpose experiment: Related technologies has been exploited including background understanding, detector fabrication, crystal growth, electronics and so on.**

Liquid Argon Dark Matter Experiment in CJPL-II

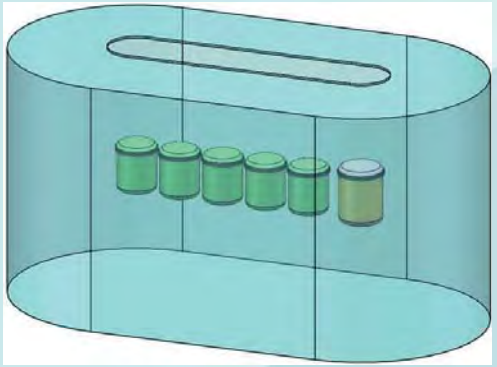


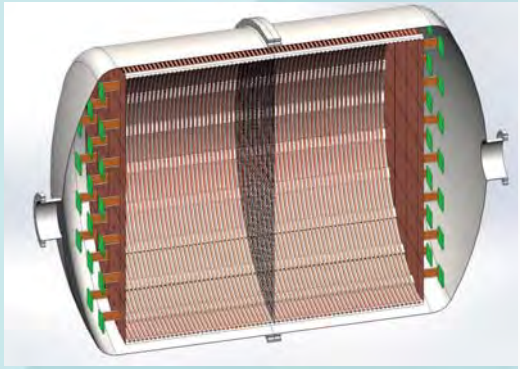


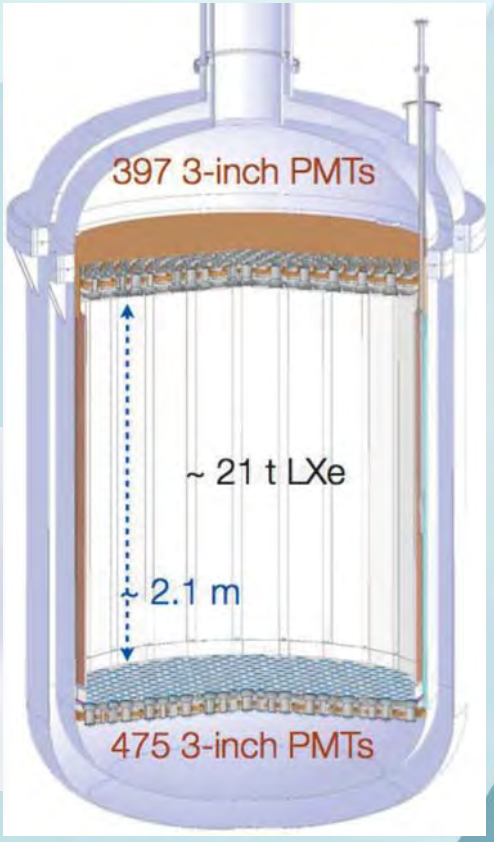
Construction of Detector in CJPL-II

- **Outer sector (14x14x14m^3): Water Cerenkov detector**
- **Middle sector in SS tank (9x9x9m^3): Liquid scintillator detector for neutron veto**
- **Inner sector (6x6x6m^3): Two phase TPC with Underground Ar**

Liquid Xeon Darkmatter Experiment-PANDAX in CJPL-II







PANDAX Develop a:

- high-energy resolution (0.5-3%FWHM)
- low-background(10^{-3} c /keV kg yr)
- large size(3~4 m^3)
- high-pressure(10-15bar) Xe136 gas TPC

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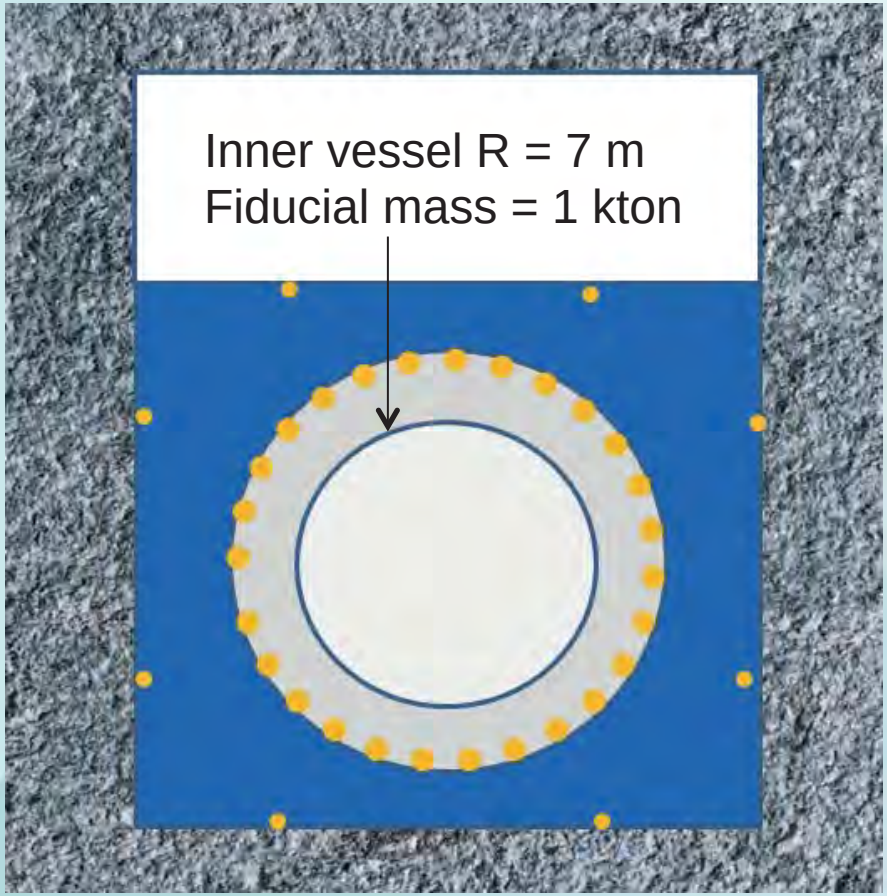
Jinping Neutrino Experiment



Two modules 1k-ton water based scintillator detectors

1) Best neutrino lab in the world
2) 24m in diameter, 35m in high
3) Physics motivation
   - Solar neutrinos
   - Supernova neutrinos
   - Geo-neutrinos
   - Atmospheric & accelerator neutrinos

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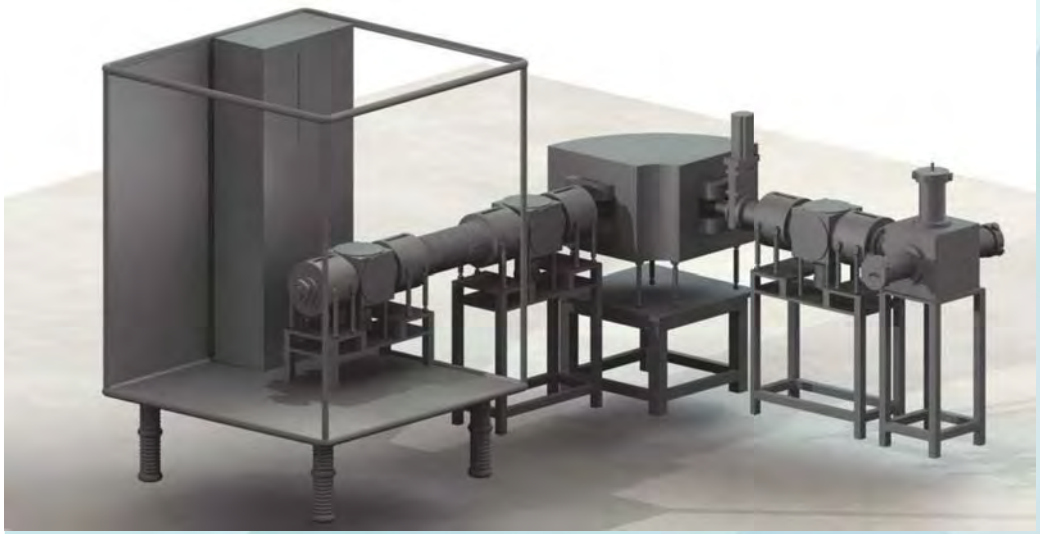
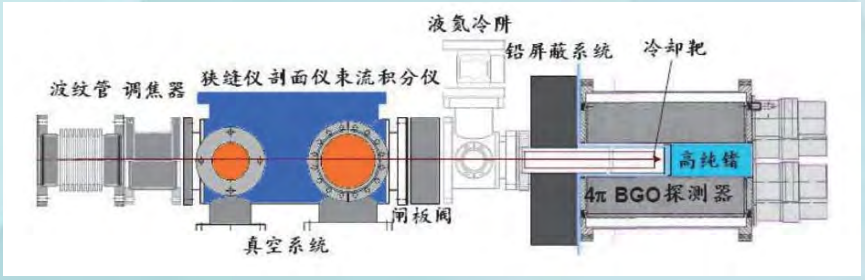
JINPING Underground Nuclear Astrophysics（JUNA）Experiment





JUNA Accelerator concept design

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JUNA experiment aims at direct measurement of (α,γ), (α,n) reactions in hydrostatic helium burning and (p, γ), (p, α) reactions in hydrostatic hydrogen burning, and will provide key input of nuclear physics for understanding evolution of stars and origin of elements.

III. RADIOACTIVITY MATERIAL CONTROL

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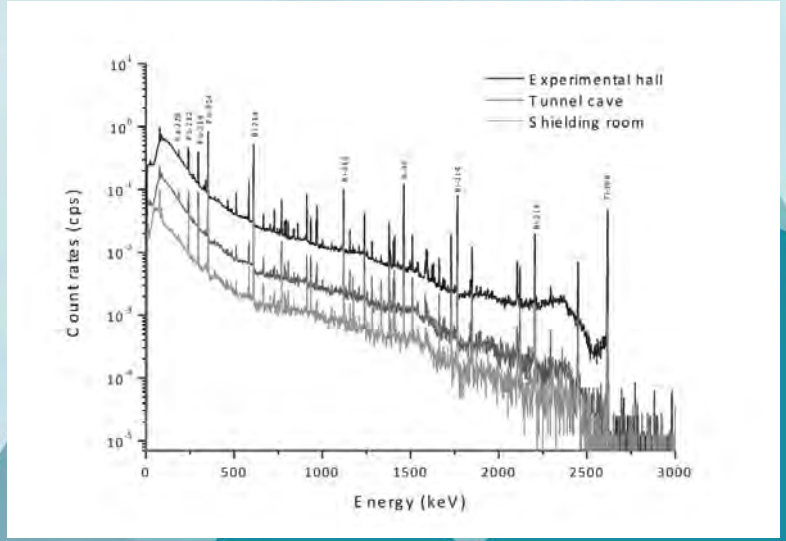
CJPL-II Radioactivity Background Control

some coal ash from electric power plant and some nano-additive were as concrete building material during the tunnel construction.

Comparison of radionuclides concentration(Bq/kg)

Radionuclide	Coal Ash	Rock
^{238}U	123.92±37.18	12.45±3.11
^{232}Th	118.6±23.79	0.41±0.03
^{40}K	356.73±71.35	9.84±2.46

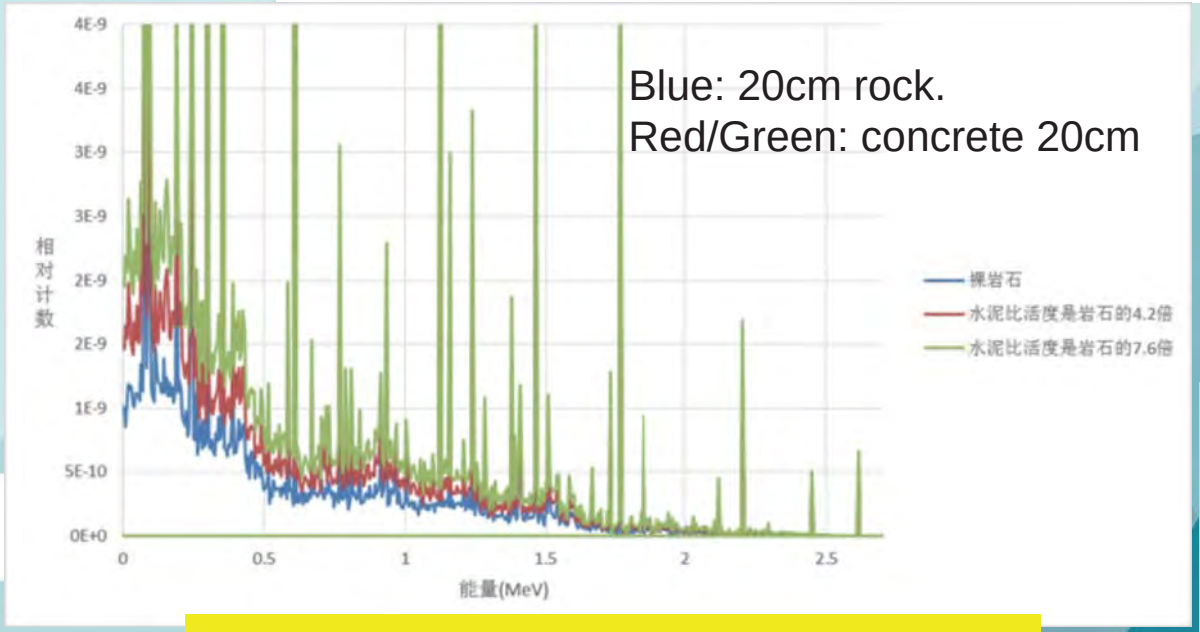


Need to control the raw material of concrete!

CJPL-II Radioactivity Background Control

The components of concrete: water, cement and aggregate. The mass ratio in 1 m^3 concrete would be 1:2:12(at this moment).

Radionuclide	Ra－226	Th－232	K－40
CJPL-I concrete	523±55	2.1±0. 3	6.4±1. 1
CJPL-II rock sample	16.54±11.07	0.95±0.72	18.92±14.71
Cement （type: Jinping 425R）	33.34±4.28	23.01±2.85	261.43±40.41



Blue: 20cm rock.
Red/Green: concrete 20cm

gamma spectrum of simulation results

rock/concrete thickness: 20cm

when the concentration of ^{238}U in the cement less than 3.0 times than that in the rock, the gamma background would be increase less than 50%.

CJPL-II Radioactivity Background Control

GeTHU, low background gamma spectrometers in CJPL-I, designed for material screening for dark mater experiment. All the raw material used during construction of CJPL-II should be investigated by GeTHU.

CJPL-I low background facility

GeTHU-I

GeTHU-II

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raw material of cement

silica

limestone

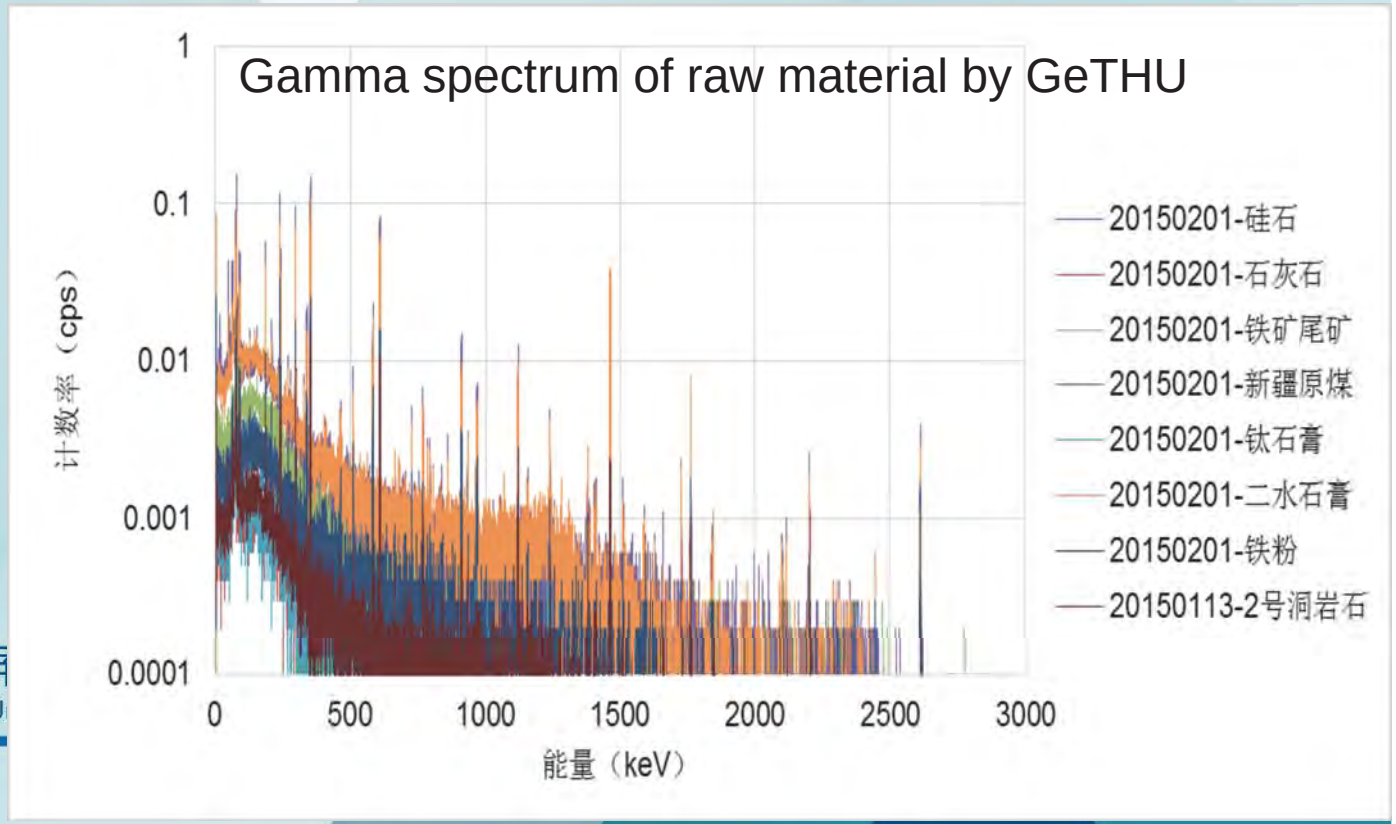
titanium gypsum

iron ore stone

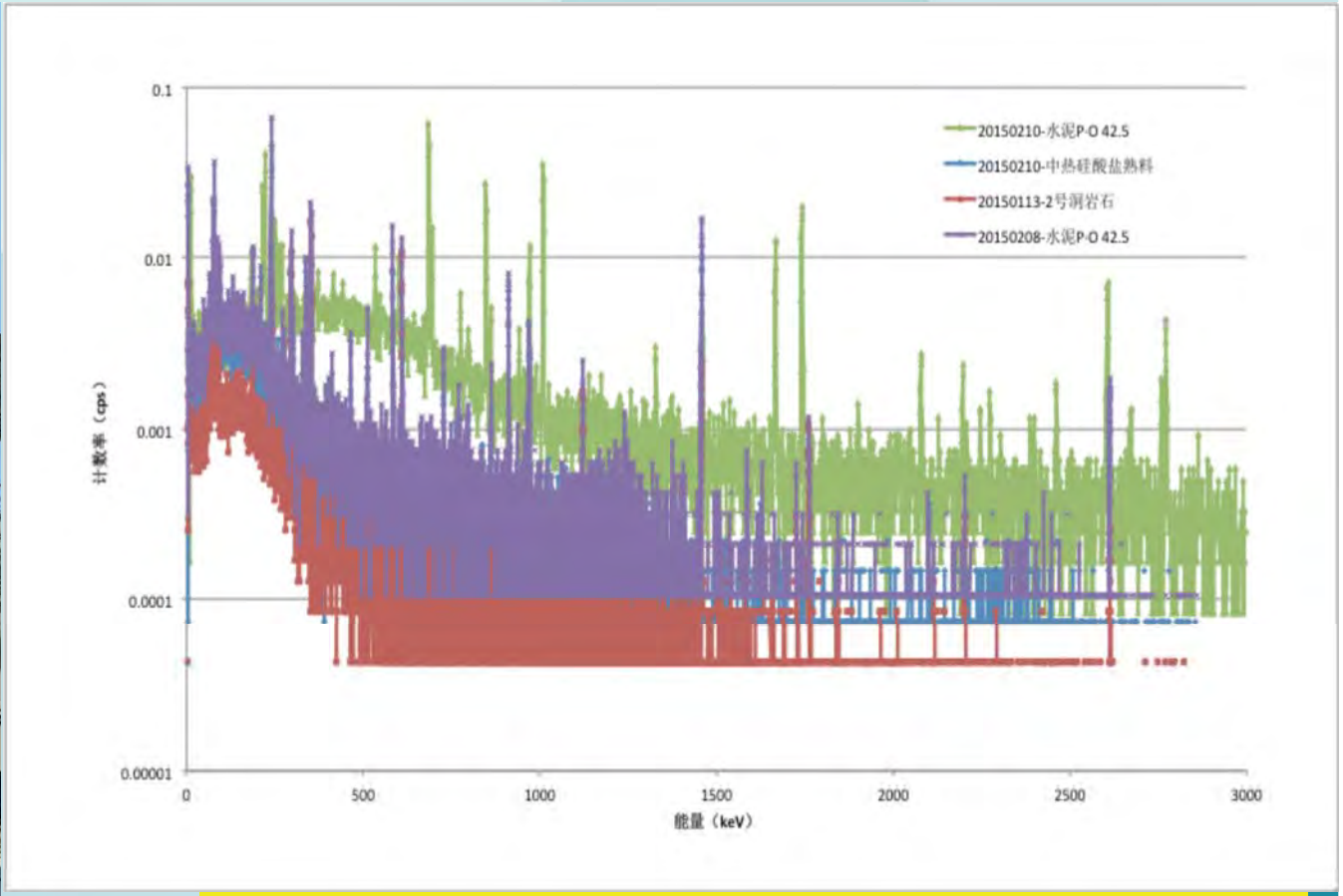
iron ash

$CaSO_4 \cdot 2H_2O$

raw coal from Xinjiang



customized Moderate heat cement



customized Moderate heat cement

gamma spectrum of different cement by GeTHU

--green： ordinary cement (20150210)(~4 times)

--blue： moderate heat cement(<3times)

--red：rock sample(base line)；

--purple: ordinary cement (20150208)(3-4time)

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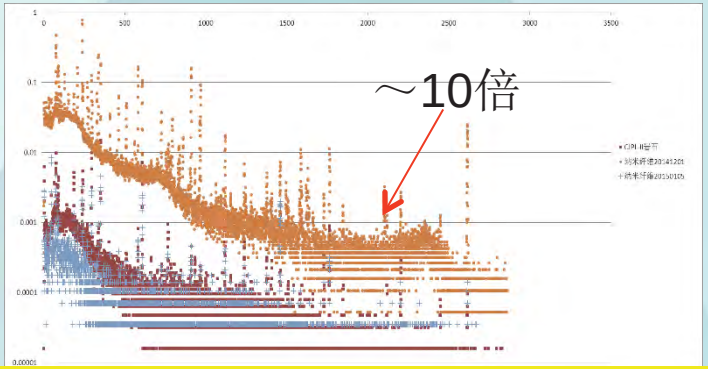
building material screening

中热水泥出厂检验

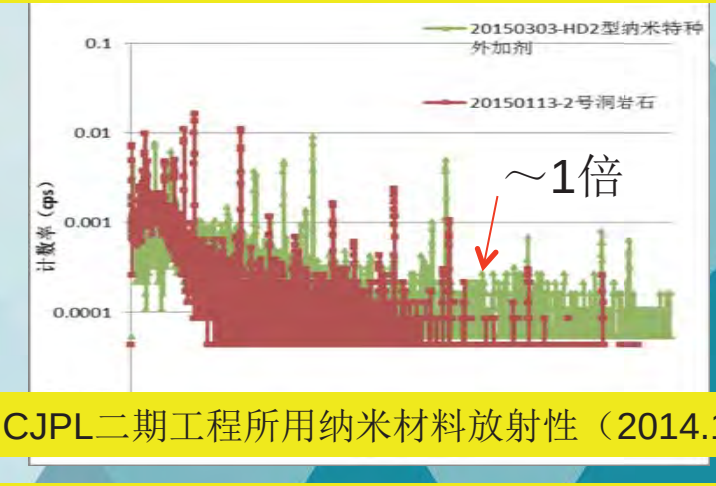
中热水泥锦屏入库检验

纳米添加剂入库检验

钢纤维入库检验



锦屏工程常用的纳米材料的放射性（2014.11前）



CJPL二期工程所用纳米材料放射性（2014.11后）

2014年11月到2015年7月，共检测了～110批次、共计200多个样品，伽玛谱仪GeTHU测量机时～700小时，排除了多个批次产品，有效控制了外部放射性材料的输入。

building material screening

steel sampling in the field

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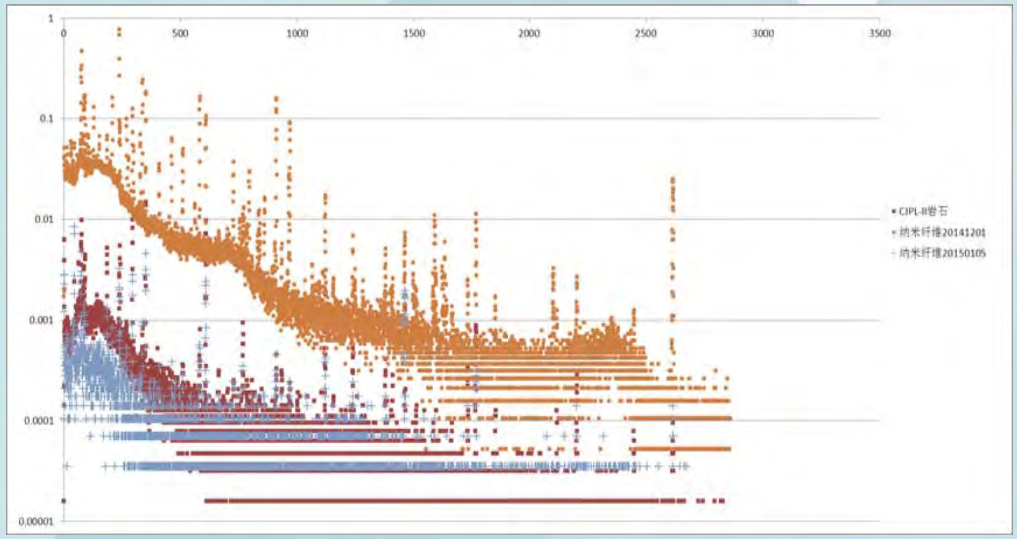
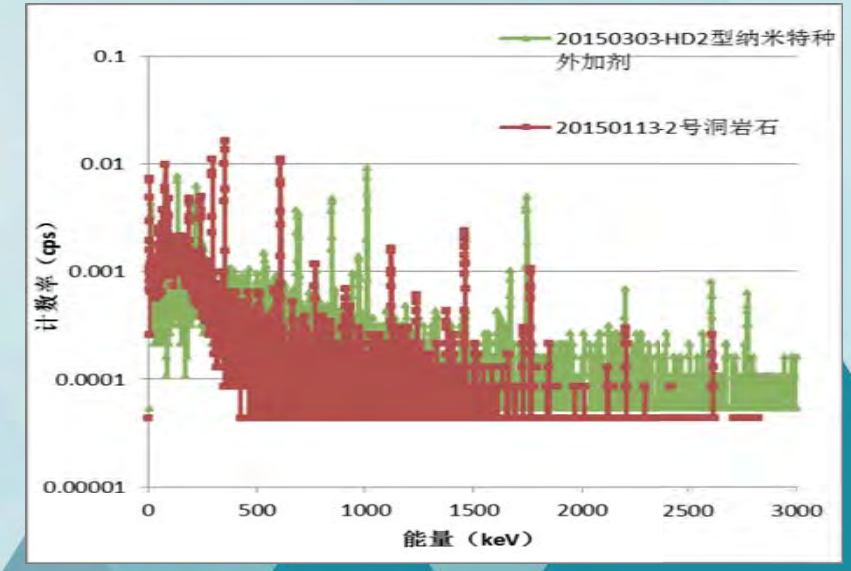
building material screening





nano-addative material sampling and gamma spectrum by GeTHU. The upper is 10 times to rock sample and can’t used in CJPL-II construction

nano-addative material sampling and gamma spectrum by GeTHU(red: rock sample baseline; green: nano -addative)

IV. PROGRESS OF CIVIL ENGINEERING

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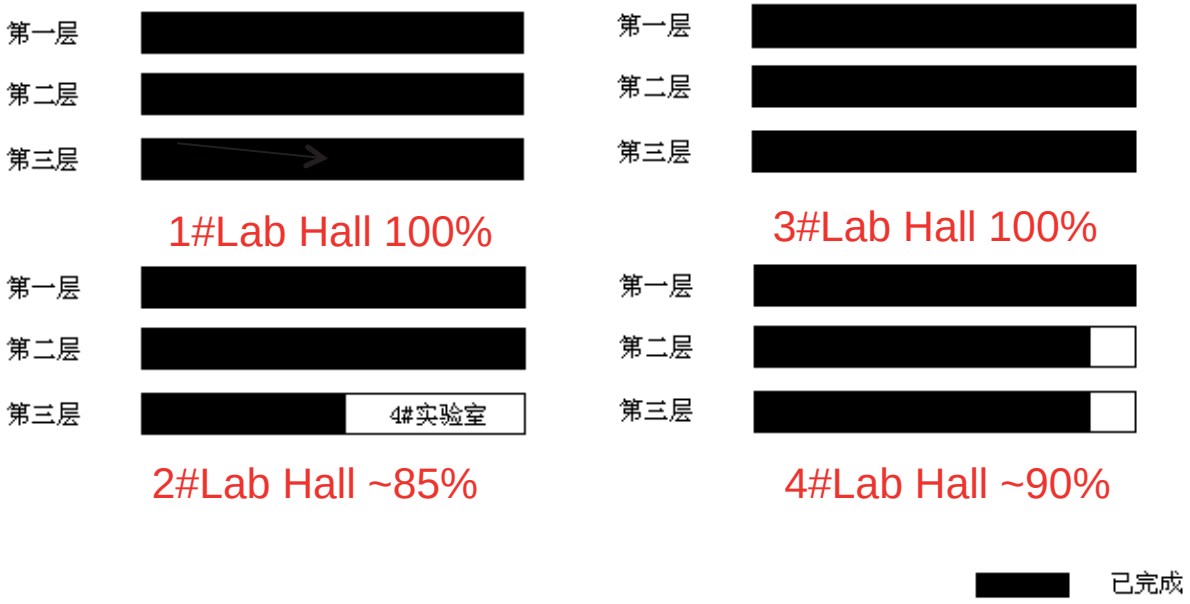
CJPL-II Construction status

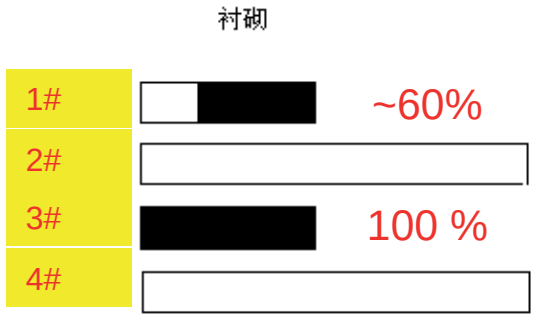
CJPL-II excavation completion(until Oct.15)



说明：

1、因实验洞断面较大，采用三层开挖施工，相对应高度分别为8.5m、4m、1.5m。
2、系统支护紧跟开挖面15m范围内。
3、1#、2#实验室已完成所有开挖支护、路面混凝土，剩余加强支护未施工。
4、1#连通洞已完成开挖、支护
5、3#实验室完成开挖、支护，剩余路面及加强支护未施工
6、4#实验室完成第一二层开挖（包含扩挖）
7、5#实验室完成开挖支护，目前正在进行加强支护预计11月份开始扩挖
8、6#实验室完成开挖、支护，剩余路面及加强支护未施工
9、7#实验室完成开挖、支护，剩余路面及加强支护未施工
10、8#实验室剩余16m第三层未开挖
11、2#连通洞剩余12m未开挖
12、3#交通洞完成衬砌，1#交通洞完成40m衬砌，其余交通洞未施工衬砌
13、辅引支洞路面未施工

lining of connecting tunnel



All excavation of Halls will be completed in the end of 2015 in the plan.

Start excavation on Nov. 01, 2014

excavation on Apr.29,2015

1# Lab Hall

2# Connecting tunnel

3# Lab Hall

4# Lab Hall

connection tunnel on Oct.15,2015

1# connection tunnel lining construction completion ~60%

3# connection tunnel lining construction completion 100%

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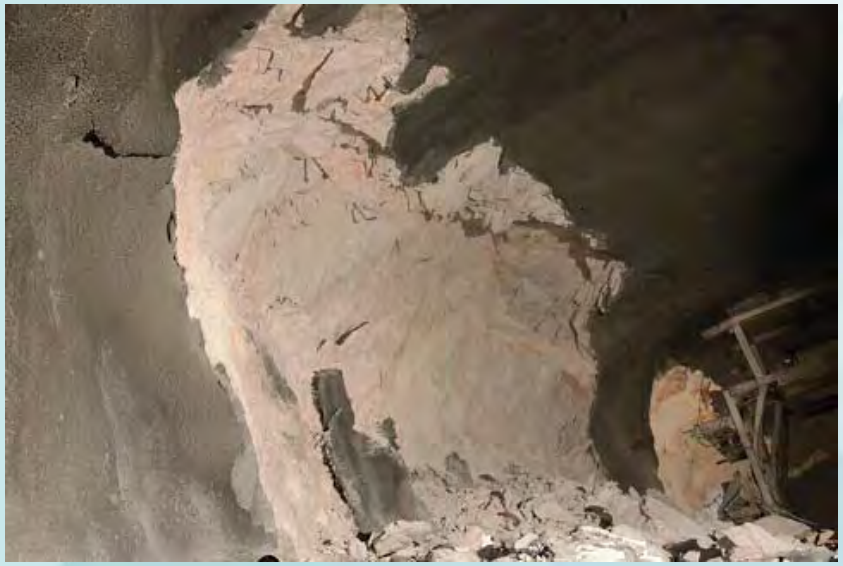
Experiment Hall on Oct.15,2015

2#Lab Hall

3#Lab Hall

4#Lab Hall

Rock burst and collapse during Construction



rock burst after digging

Dealing with the collapse

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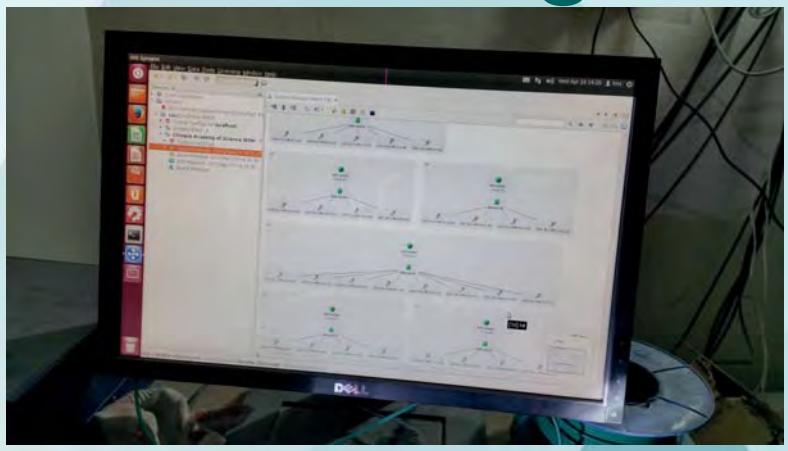
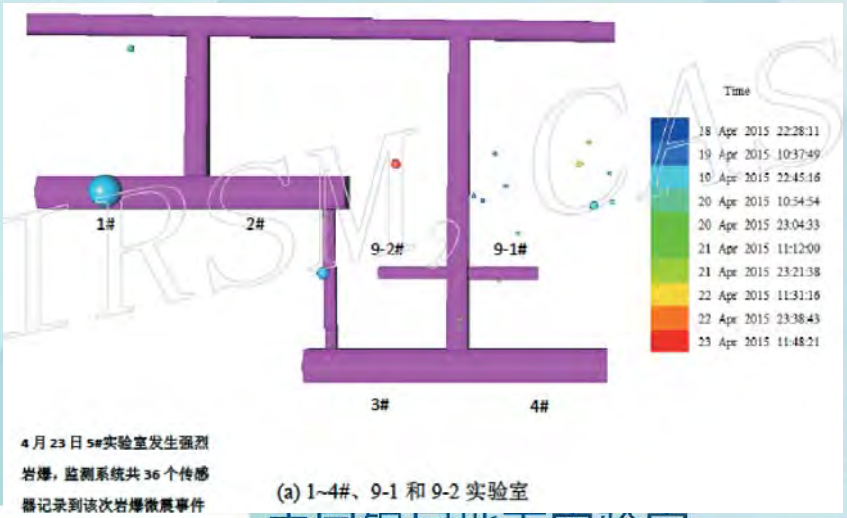
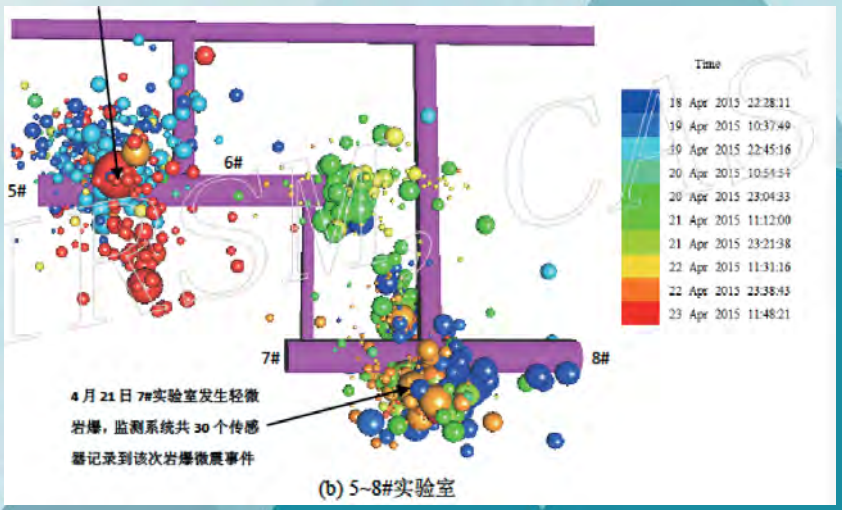
Rock burst risk prediction by microseism monitoring





(a) 1~4#、9-1 和 9-2 实验室



(b) 5~8#实验室

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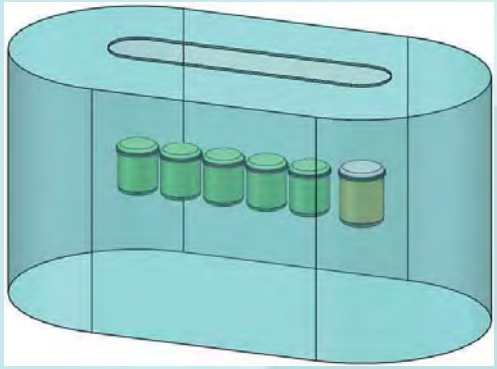
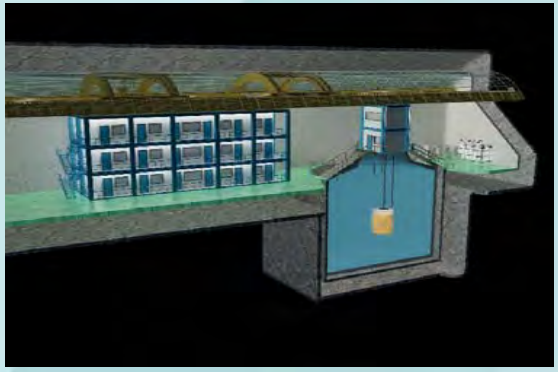
CDEX&PANDAX enlarge excavation projects



PANDAX



CDEX

NO	Project	Begin Date	Finnish Plan date
1	Enlarge excavation for PANDAX upper layer	2015/10/01	2015/11/25
2	Enlarge excavation for PANDAX lower layer	2015/11/26	2015/12/25
3	PANDAX Foundation excavation	2015/12/26	2016/03/25
4	PANDAX Foundation lining	2016/03/26	2016/05/15
5	PANDAX Corbels lining	2016/05/16	2016/06/15
6	Steady CDEX Hall	2015/10/01	2015/11/15
7	Enlarge excavation for CDEX	2015/11/16	2015/12/15
8	CDEX Foundation excavation	2015/12/16	2016/02/15
9	CDEX Foundation lining	2016/02/16	2016/03/31

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V. VENTILATION SYSTEM

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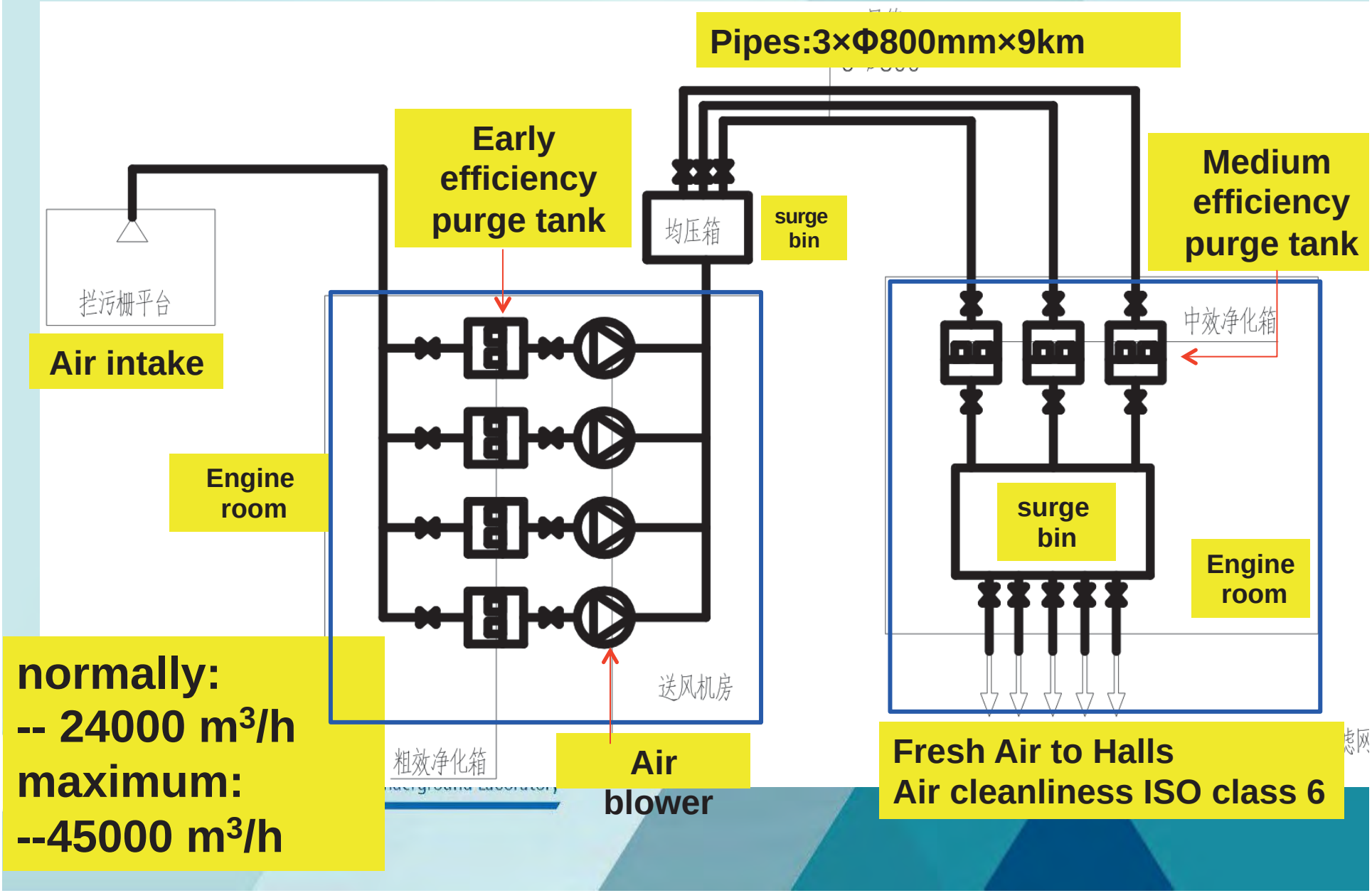
General Plan



Status of the drainage tunnel

water in the tunnel, 1~2m depth

rock debris piled along tunnel

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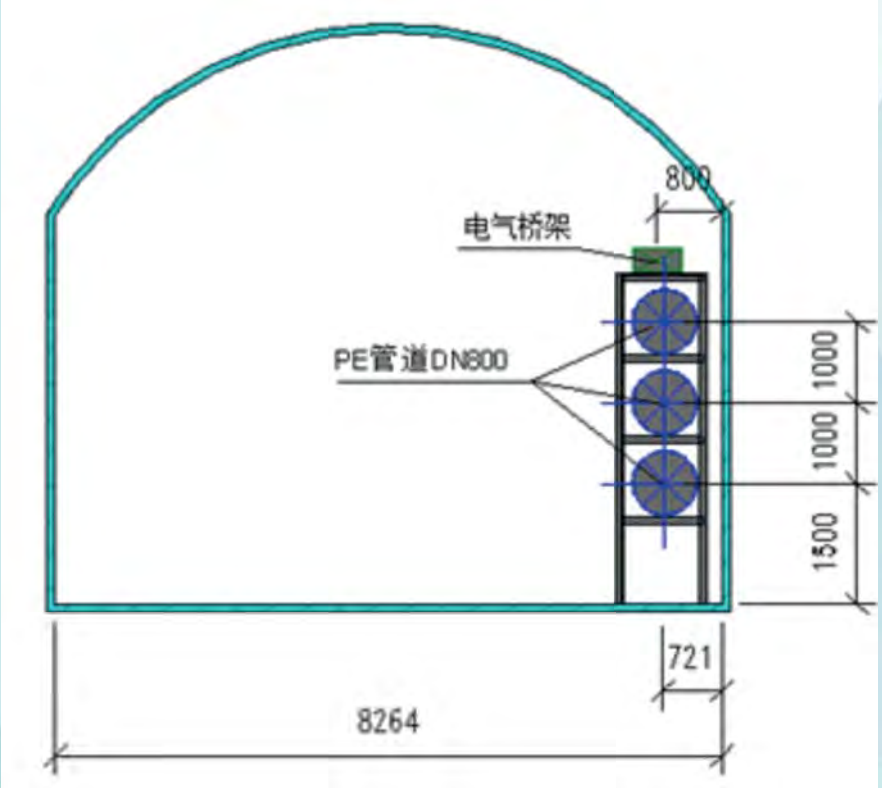
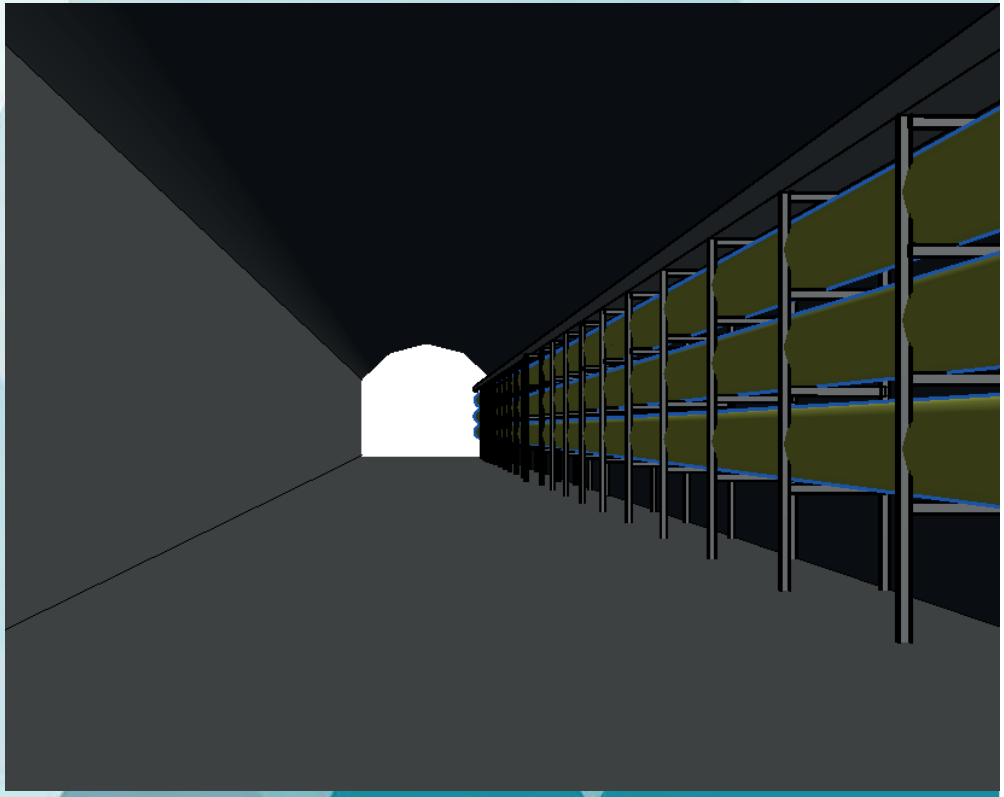
Render Picture :pipes along the wall





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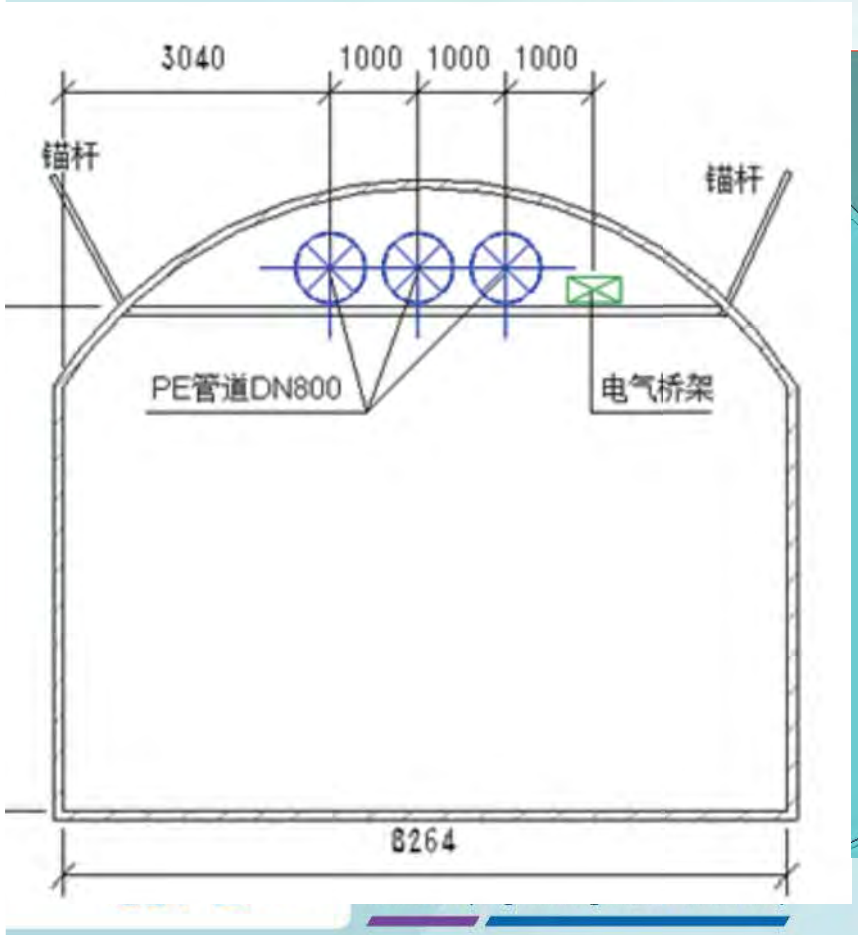
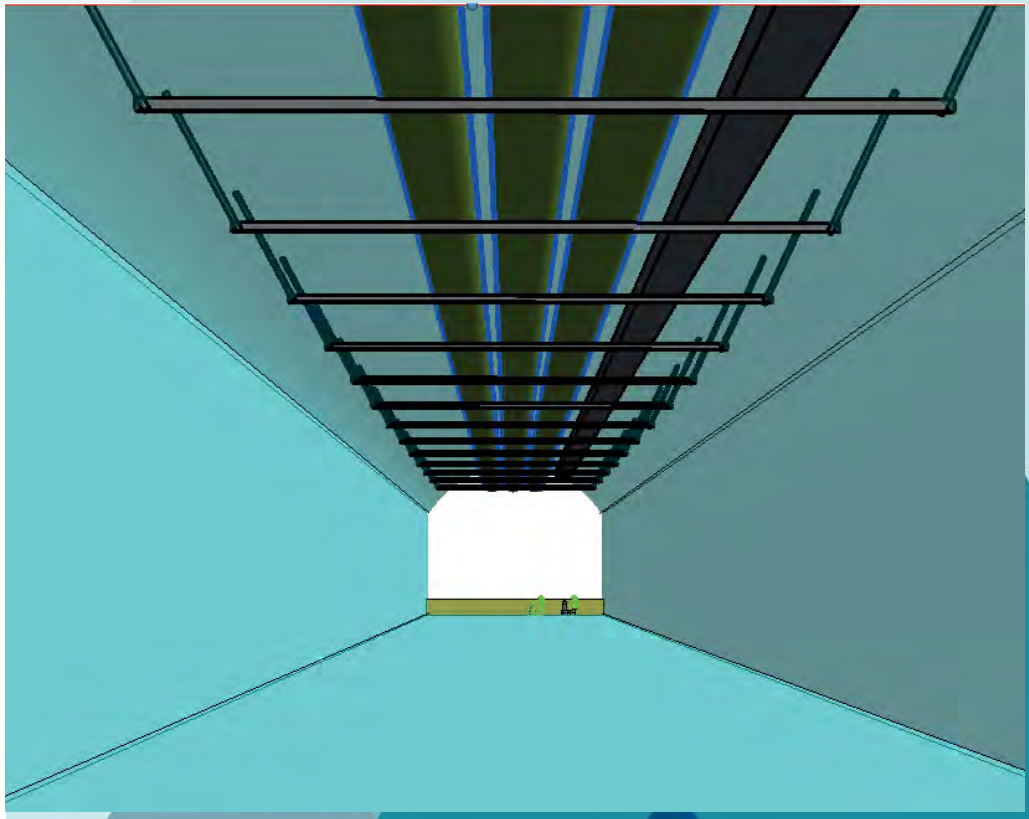
Render Picture :pipes on the top





Schedule of ventilation system

2015/09/01: design of ventilation system complete;

2015/12/31: construction plan determinated;

2016/06/30: system construction complete.

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VI. Summary

- CJPL-II has 4 130×12×12 m^3 lab halls, and its volume would be 131000m^3.
- Radioactivity material screening during CJPL-II construction;
- CJPL-II are constructing currently, and civil engine would be finished in the end of 2015;
- CJPL-II would be ready in the end of 2016,in our plan.

Thanks !

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